

What is Claimed is:

1. A horizontal optical resonator type laser diode having an optical resonator horizontally with respect to a substrate surface, comprising:

a substrate of a semiconductor;

an active layer formed inside the semiconductor;

an optical resonator mirror formed on a semiconductor facet; and

a reflection film comprising a first insulator film formed in contact with the semiconductor facet as the optical resonator mirror and an insulator film layered on the first insulator film;

wherein the first insulator film comprises aluminum oxide lacking in oxygen and composition of aluminum oxide is $\text{Al}_2\text{O}_{3-x}$ where $0.03 \leq x \leq 0.3$.

2. A laser diode according to claim 1, wherein composition of the aluminum oxide is $\text{Al}_2\text{O}_{3-x}$ where $0.1 \leq x \leq 0.2$.

3. A laser diode according to claim 1 or 2, wherein the active layer comprises a material containing aluminum.

4. A laser diode according to claim 3, wherein the aluminum content of the active layer has a compositional ratio of 10 at% or more relative to a group III element.

5. A laser diode according to claim 1, wherein an InP

substrate is used for the semiconductor substrate.

6. A laser diode according to claim 1, wherein the first insulator film is aluminum oxynitride formed by adding aluminum nitride to an aluminum oxide film lacking in oxygen.

7. A laser diode according to claim 1, wherein total stress of the reflection film defined by a sum of products of film thicknesses and internal stresses for all the layers is 150 Pa·m or less.

8. A laser diode according to any one of claims 1 to 6, wherein total stress in the reflection film is 100 Pa·m or less.

9. A method of manufacturing a horizontal optical resonator type laser diode having an optical resonator horizontal with respect to a substrate surface comprising the steps of:

providing a substrate of a semiconductor;
forming an active layer inside the semiconductor;
forming an optical resonator mirror on a facet of the semiconductor; and

forming a first insulator film in contact with the semiconductor facet as the optical resonator mirror and forming a reflection film formed by depositing an insulator film on the first insulator film;

wherein the first insulator film comprises aluminum oxide lacking in oxygen and the composition of an aluminum

oxide is $\text{Al}_2\text{O}_{3-x}$ where $0.03 \leq x \leq 0.3$.

10. A method of manufacturing a laser diode according to claim 9, further comprising the steps of:

a facet protection film or a facet reflection film having an aluminum oxide film lacking oxygen as a first layer on the semiconductor facet forming the optical resonator mirror; and

depositing the aluminum oxide film by a reactive sputtering method or an ion beam sputtering method of irradiating a metal aluminum target with plasma or ionic beams by using a gas mixture of an argon gas and an oxygen gas thereby causing film depositing reaction.

11. A method of manufacturing a laser diode according to claim 9, wherein the aluminum oxide film is deposited such that composition of argon intruded into aluminum oxide is 1 at% or less.

12. A semiconductor laser diode module wherein at least an optical lens for collecting light, an optical fiber for leading light to the outside and the laser diode according to claim 1 are integrated.